
**Working
Paper**

**Document
de travail**



**Fiscal Policy and
Economic Analysis
Branch**

**Direction de la
politique fiscale
et de l'analyse économique**

Department of Finance

Ministère des Finances

THE CYCLICALLY-ADJUSTED OUTPUT METHODOLOGY

by

**Mario Albert
Nathalie Boisvert
Robert Fonberg**

Working Paper No. 90-3

**Fiscal Policy Division
Fiscal Policy and Economic Analysis Branch
Department of Finance, Canada**

The authors would like to thank Hugh Young, John Hayward and Larry Shute from the Department of Finance for their suggestions on the development of this methodology and for comments on an earlier draft of this paper. In addition, we would like to thank Tim Creery for useful editorial comments. Any remaining errors are, of course, the responsibility of the authors.

Working papers are circulated in the language of preparation. They have received only limited evaluation and do not necessarily reflect the views of the Department of Finance. Comments on the working paper are invited and may be sent to the author.

RÉSUMÉ

Le concept de solde budgétaire gouvernemental ajusté pour la conjoncture est utilisé depuis longtemps dans la littérature économique. L'utilité principale de ce concept est de soustraire des revenus et des dépenses gouvernementales l'influence des variations conjoncturelles dans l'activité économique, de manière à établir l'orientation de la politique financière discrétionnaire. Pour être en mesure de normaliser les soldes budgétaires gouvernementaux, il faut préalablement calculer des niveaux d'emploi et de production ajustés pour les influences conjoncturelles.

Ce document présente la méthodologie du Ministère des finances pour estimer la production et l'emploi ajustés pour les variations conjoncturelles. La production ajustée est définie comme la production soutenable en moyenne sur la durée du cycle économique. C'est la production qui prévaudrait en l'absence de fluctuations dans l'activité économique, tout en tenant compte des augmentations dans l'offre des facteurs de production, des changements dans leur composition et dans la croissance de la productivité tendancielle. En estimant la production ajustée, on suppose que les facteurs de production, capital et travail, sont utilisés à leur taux d'utilisation moyen. La production ajustée est estimée au moyen d'une fonction de production Cobb-Douglas, avec progrès technologique neutre au sens de Hicks et présentant des rendements à l'échelle constants.

Les résultats empiriques montrent que la croissance de la production ajustée a diminué considérablement au cours des dernières années, passant de 5.4 pour cent par année dans les années 1960 et au cours de la première moitié des années 1970 à 3.0 pour cent par la suite. Ce déclin reflète un ralentissement dans la croissance de la productivité tendancielle des facteurs de production, celle-ci passant de 2.6 pour cent par année en moyenne avant 1974 à presque zéro dans les années 1980. Dans la première moitié des années 1990, la croissance annuelle moyenne de la production ajustée augmente à 3.2 pour cent. Ceci est attribuable à l'augmentation de la croissance de la productivité tendancielle des facteurs et à la contribution accrue provenant du stock de capital. L'augmentation dans la croissance de la productivité tendancielle des facteurs reflète les initiatives structurelles introduites par le gouvernement telles que l'Accord de libre-échange avec les États-Unis et la réforme de la taxe de vente. L'augmentation dans la contribution provenant du stock de capital reflète les opportunités accrues d'investissement à la suite de la réforme de l'impôt sur le revenu. Finalement, la réduction dans la contribution du travail à la production ajustée reflète la continuation du déclin dans les heures moyennes travaillées dans le secteur commercial de l'économie.

ABSTRACT

Cyclical adjustment of government budget balances has been long-established in the economics literature. A principal use of cyclically-adjusted budget balances is to abstract from the influence of cyclically variations in economic activity on government revenues and expenditures in order to gauge the discretionary stance of fiscal policy. In turn, this requires cyclically-neutral levels of output and unemployment for the normalization of government budget balances.

This paper presents the Department of Finance's methodology for constructing cyclically-adjusted output. Cyclically-adjusted output is defined as the output that is achievable on average over an economic cycle. It is the output that would prevail in the absence of cyclical fluctuations in economic activity taking into account increases in the supplies of factors of production, changes in their composition and trend output growth in productivity. In estimating cyclically-adjusted output, it is assumed that factors of production, capital and labour, are used at average rates of utilization. Cyclically-adjusted output is determined by a Cobb-Douglas production function, with Hicks-neutral technological progress and constant returns to scale.

The empirical results show that cyclically-adjusted output growth declined slowly from 5.4 percent per year over the 1960s and the first half of the 1970s to 3.0 percent thereafter. This decline in cyclically-adjusted output growth reflects a drop in the growth of trend multi-factor productivity from 2.6 percent per year prior to 1974 to basically no growth in the 1980s. In the first half of the 1990s, cyclically-adjusted output growth rises to 3.2 per cent as increased productivity growth and increases contribution from the capital stocks are only partly offset by a reduced contribution from the labour input. The increase in the growth of multi-factor productivity reflects the productivity improvements from the government's structural initiatives, such as the Free Trade Agreement with the United States and sales tax reform. The increased contribution from the capital stocks reflects increased incentives to invest following income tax reform. The reduced contribution from the labour input reflects a continued downward trend in average hour worked in the commercial sector of the economy.

Table of Contents

1.0	Introduction	1
1.1	Overview of the Methodology	3
2.0	Calculation of Cyclically-adjusted Labour and Capital Inputs	6
2.2.	The Normal Prime-age Male Unemployment Rate and Normal Capacity Utilization Rate Over Historical Cycles	7
2.3	Estimating Normal Employment: Total Normal Hours Worked in Commercial Sector	9
2.3.1	Estimating the Unemployment Rate Gap Elasticities	9
2.3.2	Normal Employment and Total Smoothed Hours Worked in the Commercial Sector	16
2.3.3	Smoothed Hours Worked	17
2.3.4	Results	18
2.4	Estimating the Cyclically-adjusted Level of the Capital Input	18
3.0	Technology and Trend Multi-factor Productivity	20
3.1	Technology and Total Factor Productivity	20
3.2	Estimating Trend Multi-factor Productivity	21
4.0	Cyclically-adjusted Output Estimates	23

the unemployment rate and the level of output⁴. In line with statistical approaches, factor input utilization rates are normalized at average rates of utilization over each business cycle.

Constructed in this way, cyclically-adjusted output represents an attainable rate of economic activity over the short to medium term. In contrast, the alternative concept of full-employment output based on the natural rate of unemployment does not necessarily represent attainable rates of factor utilization even in the medium term. Theoretically, full-employment output can be defined as the output that would prevail if the markets for all factors of production were in equilibrium. Full-employment output is achieved when the actual unemployment rate is equal to the natural rate of unemployment with the natural rate of unemployment defined as the market clearing rate in a general equilibrium sense. Rigidities in the labour market may mean that this full-employment state can only be attained in the long run, if at all. In the absence of systematic labour market rigidities, long-lasting supply and demand shocks or destabilizing economic policies, however, normal and full-employment output estimates would tend to converge in the longer term, although they may diverge significantly for extended periods.

The cyclically-adjusted output concept is used for two main reasons. First, in the context of a government medium-term planning horizon, Bruce and Purvis (1986) argued that it would be imprudent to base estimates of the cyclically-adjusted budget balance on a pure concept of full-employment output that might not be achievable on average over the medium term. In the context of examining whether the fiscal situation is compatible with achieving a predetermined stable long-term debt-to-GDP ratio, they argue that a potential or full-employment concept would lead to a biased analysis since the cyclical component of the deficit does not average to zero in the medium term. This point has also been made in a similar context by Buiter (1983).

Second, for the purpose of calculating cyclically-adjusted budget balances the concept of cyclically-adjusted output is judged less controversial, both theoretically and empirically. Cyclically-adjusted balance estimates are published regularly and are established indicators of the fiscal stance, recognized as such by economists. The credibility of these estimates, to some extent, rests on the use of relatively non-controversial concepts. Recent estimates of the natural rate of unemployment

4. The general approach followed here has been used by various researchers in the United States in recent years; for example, Perry (1977), Clark (1979), and McClain and Waite (1980).

1.0 Introduction

Cyclically-adjusted output is the key variable in the calculation of the cyclically-adjusted budget balances. It is the basis for the calculation of the output gap measure and for the adjustment of the various revenue components for cyclical variations in economic activity. Cyclically-adjusted output is therefore pivotal in assessing the fiscal stance of governments in Canada.

Cyclically-adjusted output is defined as the output that is achievable on average over an economic cycle. It is the level that would prevail in the absence of cyclical fluctuations in economic activity taking into account increases in factor supplies, changes in their composition and trend growth in productivity. In estimating cyclically-adjusted output it is assumed that factors of production are utilized at average or normal rates. These are the cyclically-adjusted or normal unemployment rate and capacity utilization rate.

Alternative definitions of trend output could be used as the basis for cyclical adjustment. Estimates of trend output that have been used in recent years have been derived using two different techniques: equilibrium methods and statistical methods.² Equilibrium methods use such concepts as potential output, high-employment output and full employment output. These are usually defined as the maximum volume of output that the economy can produce, sometimes defined to include an inflation constraint, such as the level of output associated with the non-accelerating inflation rate of unemployment (NAIRU).³ The statistical methods include time series techniques for smoothing actual output, for example, moving averages and the linking of points in the business cycle, such as middle expansion values. The method used here to construct cyclically-adjusted output combines elements of both approaches. For example, in accordance with the equilibrium approach, an attempt is made to account for the impact of changes in the composition of the labour force on

-
1. Gigliotti (1990) describes the methodology used in constructing cyclically-adjusted budget balances.
 2. Bredenkamp (1988).
 3. Denison (1981) provides a useful review of the evolution of the concept of potential output from the period when it was accompanied by a price stability constraint. Denison argues that the measure of potential should be based on supply capacity at high employment -- prices should not enter the definition.

in Canada, which is a key input into the construction of a full-employment output series, range from 6 to 12 per cent depending on the theoretical and empirical approach used. Therefore, cyclical adjustment based on a full-employment concept would be open to criticism on both theoretical and empirical grounds.

1.1 Overview of the Methodology

The basic output measure used in the construction of the cyclically-adjusted output series is gross domestic product (GDP) at factor cost. By definition, GDP includes the output of both commercial and non-commercial industries.⁵ For the commercial sector, the methodology adopted in this paper uses a two-factor production function to calculate cyclically-adjusted output. The production function relates cyclically-adjusted output of the sector to the cyclically-adjusted or normal levels of labour and capital inputs and total factor productivity.

Non-commercial output is assumed to be non-cyclical -- actual and cyclically-adjusted are identical -- and is added to cyclically-adjusted commercial output to obtain cyclically-adjusted GDP at factor cost. The non-commercial sector consists mainly of the government sector.

The cyclically-adjusted labour input, or normal employment measured in hours, is defined as normal hours worked per employee, times one minus the normal unemployment rate, times the smoothed labour force. The normal employment series is constructed from disaggregated age-sex cohort labour market data. This is done in two steps. First, smoothed participation rates are multiplied by the source population for each cohort to obtain estimates of the smoothed labour force. Second, the cyclical components of movements in the unemployment rates of the various cohorts are removed: normal unemployment rates for each cohort are estimated as a function of the unemployment rate gap for prime-age males and a set of structural variables. These unemployment rates are used to obtain the normal employment rates for each cohort; those are, in turn, multiplied by the respective smoothed labour force estimates and summed to obtain aggregate normal employment.

-
5. To obtain commercial sector output, total government wage expenditures, total government capital consumption allowances and the value of paid and imputed rents are removed from total GDP at factor cost.

This detailed approach to the calculation of aggregate normal employment and the aggregate normal unemployment rate has been adopted because the aggregate unemployment rate has fluctuated over time due to changes in the age-sex composition of the labour force. These shifts are important because different age-sex cohorts show different and changing degrees of labour force attachment and unemployment experience. Changes in the age-sex composition of the labour force have produced significant changes in the aggregate unemployment rate unrelated to the cyclical state of the economy. The unemployment rate of prime-age males is generally regarded as providing a better indicator of cyclical developments in the labour market. This group's attachment to the labour market has been very stable over time and, consequently, fluctuations in the unemployment rate of this group have closely reflected cyclical fluctuations in demand and output.

With respect to the capital stock, the normal rate of capacity utilization is defined as the average rate over each cycle. Further, the actual capacity utilization series used in estimating the production function is normalized by dividing by its mean over each cycle. Consequently, the normal rate of capacity utilization over each cycle is equal to one. The actual total stock of capital owned by the commercial sector is implicitly assumed to equal its normal level.

The basic methodological approach to the calculation of cyclically-adjusted output is summarized by the following five relationships:

$$Y_N = Y_{NC} + Y_{NNC} \quad (1)$$

$$Y_{NC} = TMP * NEC^\alpha * KN^{(1-\alpha)} \quad (2)$$

$$NE(i) = POP(i) * PRS(i) * (1 - NUR(i)) \quad (3)$$

$$NEC = SPEC * 52 * SAHWC * \sum_{i=1}^6 NE(i) \quad (4)$$

$$TMP = A_0 e^{\delta t} \quad (5)$$

where:

Y_N: Total cyclically-adjusted output.
 Y_{NC}: Cyclically-adjusted output of the commercial sector.
 Y_{NNC}: Cyclically-adjusted output of the non-commercial sector (equal to observed output).
 NEC: Normal hours worked in the commercial sector.
 KN: Normal capital used in the commercial sector.

α :	Share of labour income in the commercial sector factor income.
TMP:	Trend multi-factor productivity of the commercial sector.
NE(i):	Normal employment of cohort i.
POP(i):	Source population of cohort i.
PRS(i):	Smoothed participation rate of cohort i.
NUR(i):	Normal unemployment rate of cohort i.
SPEC:	Smoothed proportion of commercial sector employment in total employment.
SAHWC:	Smoothed average weekly hours worked in the commercial sector.
A_0 :	Scaling factor
δ :	Trend growth rate of multi-factor productivity.
i:	Young males/females (aged 15-24), prime-age males/females (aged 25-54), older males/females (aged 55+).

The first equation defines cyclically-adjusted output as the sum of cyclically-adjusted output in the commercial and non-commercial sectors. The second equation is the production function relating cyclically-adjusted output of the commercial sector to the normal levels of labour and capital inputs and trend total factor productivity. The third equation defines normal employment for cohort i as the product of the source population POP(i), the smoothed participation rate PRS(i) and the normal employment rate (1-NUR(i)) for each cohort. The fourth defines total normal employment in the commercial sector as the product of the smoothed proportion of commercial sector employment in total employment, smoothed average weekly hours worked in the commercial sector and the sum across cohorts of normal employment. The fifth equation expresses the assumption that trend multi-factor productivity grows at an exogenously determined rate of δ .

The remainder of the paper is structured as follows. Section two presents the procedure used to estimate cyclically-adjusted capital and labour inputs. The third section presents the issues related to the estimation of trend multi-factor productivity based on the production function approach. Finally, the fourth section contains a discussion of the cyclically-adjusted output estimates.

2.0 Calculation of Cyclically-adjusted Labour and Capital Inputs

The key to the calculation of cyclically-adjusted output is the estimation of cyclically-adjusted or normal levels of employment and the capital stock over the business cycle. Section 2.1 dates economic cycles over the 1951 to 1989 period. Section 2.2 estimates the normal prime-age male unemployment rate and the normal capacity utilization rate over historical cycles. Section 2.3 estimates in detail total normal hours worked in the commercial sector. Specifically, this section examines issues related to the estimation of unemployment gap elasticities, smoothed participation rates and smoothed average hours worked in the commercial sector. Finally, section 2.4 discusses the estimation of the normal level for the capital stock.

2.1 Dating Historical Economic Cycles in Canada

The first step in the construction of normal factor utilization rates is the dating of economic cycles. This dating is used in the calculation of the normal unemployment rate for prime age males and the normal capacity utilization rate. Table 2.1.1 provides dates of the economic cycles in Canada over the 1951 to 1989 period. This dating is based on the Statistics Canada study by Philip Cross (1982). The cycles identified in this table have been adjusted to take account of data released since 1982 as well as historical revisions to the national accounts. The impact of the data revisions on cycle dates is minor.

According to the Cross study, there were six complete business cycles in Canada between 1951 and 1981.⁶ A simple arithmetic average would put the mean length of these cycles at about 5 years, with recessions lasting about 10 months and expansions about 50 months. There has been considerable variation in the length of these cycles, with the longest lasting 170 months and the shortest lasting only 20 months. Similarly, there has been considerable variance in the length of cyclical phases, particularly expansions, with the longest running 160 months and the shortest lasting only 12 months. Recessions have

6. While Cross focuses on real output changes in the determination of turning points, it would be an oversimplification to suggest that a recession is marked strictly by two consecutive quarterly declines in real GDP. While this would be a sufficient condition, Cross's methodology does not treat it as necessary. Rather it is argued that "one must assess each recessionary period separately to appraise the duration, dispersion, and depth behind the contraction of aggregate output".

been more uniform in duration with the longest lasting 16 months and the shortest running for seven months.

Table 2.1.1
Dating Economic Cycles in Canada
1951 to 1989

		<u>Starting</u> (mo./yr.)	<u>Ending</u>	<u>Duration</u> (months)
I.	RECESSION	06/51	- 12/51	7
	EXPANSION	01/52	- 05/53	17
	CYCLE	06/51	- 05/53	24
II.	RECESSION	06/53	- 06/54	13
	EXPANSION	07/54	- 01/57	31
	CYCLE	06/53	- 01/57	44
III.	RECESSION	02/57	- 01/58	12
	EXPANSION	02/58	- 03/60	26
	CYCLE	02/57	- 03/60	38
IV.	RECESSION	04/60	- 01/61	10
	EXPANSION	02/61	- 05/74	160
	CYCLE	04/60	- 05/74	170
V.	RECESSION	06/74	- 03/75	10
	EXPANSION	04/75	- 10/79	55
	CYCLE	06/74	- 10/79	65
VI.	RECESSION	11/79	- 06/80	8
	EXPANSION	07/80	- 06/81	12
	CYCLE	11/79	- 06/81	20
VII.	RECESSION	07/81	- 10/82	16
	EXPANSION	11/82	- ??/??	??
	CYCLE	07/81	- ??/??	??

2.2. The Normal Prime-age Male Unemployment Rate and Normal Capacity Utilization Rate Over Historical Cycles

Table 2.2.1 presents the average or normal prime-age male unemployment rate (PAMNUR) over each of cycle since 1951. While there has been some movement in the PAMNUR since the early 1950s, this movement has been limited. Excluding the 1951-1953 cycle

the PAMNUR has fluctuated between 3 and 5 per cent; in contrast, in the current cycle from July 1981 through September 1989, it averaged 7.8 per cent. The normal capacity utilization rate (CAPNUR), on the other hand, has been declining steadily since 1960. The decline has been particularly pronounced since 1979. Capacity utilization rates have returned, in the second half of the 1980s, to levels comparable with those on average in the 1970s.

Table 2.2.1
PAMNUR and CAPNUR by Cycle
1951 to 1989

		<u>Starting</u> <u>Ending</u>	<u>Duration</u>	<u>PAMNUR</u>	<u>CAPNUR</u>
		<u>(mo./yr.)</u>	<u>(months)</u>	<u>(per cent)</u>	<u>(per cent)</u>
I.	CYCLE	06/51 - 05/53	24	2.3	N.A.
II.	CYCLE	06/53 - 01/57	44	3.1	N.A.
III.	CYCLE	02/57 - 03/60	38	4.7	N.A.
IV.	CYCLE	04/60 - 05/74	170	3.8	.904
	a.	04/60 - 12/69	117	3.7	.910
	b.	01/70 - 05/74	53	3.8	.895
V.	CYCLE	06/74 - 10/79	65	4.5	.850
VI.	CYCLE	11/79 - 06/81	20	4.8	.819
VII.	CYCLE	07/81 - ?/??	--	7.8(a)	.815(a)

(a) Average over the first 99 months of the cycle -- July 1981 through September 1989.

N.A.: Not available.

2.3 Estimating Normal Employment: Total Normal Hours Worked in Commercial Sector

The measure of employment used in the production function is total hours worked in the commercial sector. This section describes how the normal level of this variable is estimated, based on the prime-age male unemployment gap. In brief, the normal unemployment rate of each non-prime-age male cohort is estimated by assuming a stable relationship between the prime-age male unemployment rate gap and the unemployment gaps of each of the other cohorts. Again, owing to the strong and stable attachment of the prime-age male to the labour market, variations in this cohort's unemployment gap are considered to give a good indication of demand fluctuations. Once the normal unemployment rate for each cohort is obtained, normal employment is estimated by multiplying the smoothed labour force by one minus the normal unemployment rate. Aggregate employment obtained from this calculation is then multiplied by the smoothed proportion of employment in the commercial sector, and the smoothed average weekly hours worked in the commercial sector to give total hours worked in the commercial sector.

2.3.1 Estimating the Unemployment Rate Gap Elasticities

This sub-section describes how the disaggregated unemployment-rate-gap elasticities with respect to the prime-age male unemployment rate gap. The first part presents the model; the second discusses the estimation results. The discussion draws in part on Grignon (1984).

2.3.1.1 The model

The elasticity of a given cohort's unemployment rate gap to the prime-age male gap can be estimated using the following relationship:

$$\log(\text{NUR}(i)_t / \text{UR}(i)_t) = u_{el} * \log(\text{PAMNUR}_t / \text{PAMUR}_t) \quad (6)$$

where:

NUR(i):	Normal unemployment rate of cohort i.
UR(i):	Unemployment rate of cohort i.
PAMNUR:	Prime-age male normal unemployment rate.
PAMUR:	Prime-age male unemployment rate.
u_{el} :	Parameter.

The parameter u_{el} in this equation is the elasticity of the unemployment rate gap of cohort i to the prime-age male unemployment rate gap. The relation described in (6) constrains the gap elasticities to be constant.

However, equation (6) cannot be estimated directly as the adjusted unemployment rates of the non-prime-age-male cohorts $NUR(i)$ are not known. However, equation (6) can be rewritten as:

$$\log(UR(i)_t) = \log(NUR(i)_t) - u_{el} * \log(PAMNUR_t/PAMUR_t) \quad (7)$$

If $NUR(i)$ is constant over time, equation (7) can be estimated directly. There are reasons to believe, however, that the $NUR(i)$ have varied in response to structural and demographic factors. Accordingly, we postulate that the normal unemployment rate of each cohort is a function of a set of structural and demographic variables.

Structural Factors

Structural factors expected to influence the cohort's unemployment rate basically relate to government policies affecting the labour market. The most important are the unemployment insurance (UI) program and the minimum wages.

An increase in the generosity of the UI program should exert upward pressures on the unemployment rates of the various cohorts, as higher UI benefits reduce the incentive to work. The generosity of the UI program increased substantially in 1972 with the implementation of the Unemployment Insurance Act in that year. This reform basically involved increased coverage, liberalization of eligibility and increased duration and size of benefits. Subsequent revisions of the Act in 1975, 1977, 1978 and 1988 have reduced the generosity and coverage of the UI program.

The index used in this study to capture changes in generosity of the UI program was constructed by MacGregor (1988). It is a modified version of an index proposed by Fortin (1984). The index is estimated as the product of the labour force coverage rate of UI, the ratio of net after-tax UI benefits to a net after-tax wage, and the ratio of the maximum duration of benefits to the minimum number of weeks of work required for qualification for benefits. These three components take into account the three relevant aspects of the program: coverage, generosity and eligibility. The generosity ratio, and particularly the eligibility ratio, are functions of regional unemployment rates and eligibility criteria. To take account of

these phenomena, each component was first calculated by province and then aggregated.

From a theoretical point of view, a higher minimum wage is generally viewed as having a negative effect on employment in the long run. This occurs as firms substitute other inputs for the relatively more-highly-priced labour and reduce output as a result of poorer allocative efficiency. Since the setting of minimum wages is almost exclusively within provincial jurisdiction, the minimum wage index is obtained as a weighted average of the respective provincial minimum wages divided by average hourly earnings in the commercial sector. Provincial weights equal each province's labour force as a share of the total Canadian labour force and therefore vary over time.

Another structural factor that can affect the unemployment rate is the degree of unionization. An increase in unionization should have an upward impact on unemployment rates to the extent that unions raise wages indirectly by restricting supply or directly by increasing wages. To reflect this consideration, we use Fortin's (1984) measure of unionization: total union membership as a percentage of non-agricultural employment. Fortin notes that there is a possibility of multicollinearity between the minimum wage ratio and the union variable implying less precise t-tests for these variables.

Demographic Factors

Many analysts have pointed out that part of the increase observed in historical unemployment rates could be due to shifts in demographic structures. Consequently, a number of demographic variables have been included in the equations to take account of the influence on the unemployment rate of each cohort caused by changes in the participation rates of the various cohorts. In the presence of wage rigidities, variations in the labour supply of one cohort may result in an increase in the unemployment rate of this or other cohorts if there is some degree of substitutability between the groups. To capture the effect of the increased entry of women into the labour force and increases in the share of prime-age persons in the working-age population, each of the equations includes the ratio of the prime-age female labour force to the prime-age male labour force ($LFF2554/LFM2554$), and the ratio of the young labour force to that of prime-age male ($LF1524/LFM2554$).

In addition, to capture the effect of declining birth rates, fertility rates are included in the young and prime-age female equations. The fertility rate is defined as the number of children per 1000 women. The presence of children could encourage women to retire from the labour market for short periods of time while remaining in the labour force. In

the prime-age female equation, considering the possible high multicollinearity between the fertility rate of women aged 25 to 54 (FERT2554) and the ratio of the prime-age female labour force to the prime-age male labour force (LFF2554/LFM2554), it was decided to include only one of the two variables.

Other factors such as the increase in school enrolment, the dispersion of employment growth across industries, and employment and wage policies of the public sector have been identified in a number of different studies as affecting the level of unemployment rates. We did not attempt to include these variables considering the important list of structural and demographic variables already considered.

In summary, the normal unemployment rate of each cohort is assumed to be a function of an unemployment insurance index (UIG), the ratio of the young female labour force to the prime-age male labour force (LF1524/LFM2554), the ratio of prime-age female labour force to prime-age male labour force (LFF2554/LFM2554), an index of minimum wage (WMR), an index of unionization (UNION), and for young and prime-age female equations, the fertility rate of each cohort (FERT). The equation takes the following general form:

$$\log(\text{NUR}(i)_t) = \alpha_0 + \alpha_1 * \text{UIG}_t + \alpha_2 * \text{UNION}_t + \alpha_3 * \text{WMR}_t + \alpha_4 * (\text{LF1524}_t / \text{LFM2554}_t) + \alpha_5 * (\text{LFF2554}_t / \text{LFM2554}_t) \quad (8)$$

Combining equations (7) and (8) we get:

$$\log(\text{UR}(i)_t) = \alpha_0 - u_{e1} * \log(\text{PAMNUR}_t / \text{PAMUR}_t) + \alpha_1 * \text{UIG}_t + \alpha_2 * \text{UNION}_t + \alpha_3 * \text{WMR}_t + \alpha_4 * (\text{LF1524}_t / \text{LFM2554}_t) + \alpha_5 * (\text{LFF2554}_t / \text{LFM2554}_t) \quad (9)$$

In a situation where there are wage and labour market rigidities, it is reasonable to consider that these structural and demographic variables do not impact instantaneously on unemployment rates. For example, when the minimum wage or the labour force increases, employees are not automatically laid off; there is an adjustment period. In order to take these rigidities

In the long run, $UR(i)_t$ is equal to $UR(i)_{t-1}$. Imposing this condition in equation (13), we get:

$$\log (UR(i)_t) = \theta_1/(1 - \theta_4) + \theta_2/(1 - \theta_4)*SD_t + \theta_3/(1 - \theta_4)*\log (PAMNUR_t/PAMUR_t) \quad (14)$$

The long-term elasticity of the cohort's unemployment rate to the gap is then equal to $\theta_3/(1 - \theta_4)$.

2.3.1.2 Estimation Results

Table 2.3.1 presents the estimation results for each of the unemployment rate gap equations of the various cohorts. The estimation was performed using OLS over the 1961:1 to 1989:2 period. Based on standard statistics, corrected R^2 and coefficient of variation, the estimated equations fit very well.

Variables with signs considered to be theoretically incorrect were omitted from the equations while variables with insignificant coefficients but the expected signs were retained. Using this criteria, WMR was removed from all equations while the UNION variable was left in some but its coefficient was never significantly different from zero. All data entering in the unemployment rate gap equations are provided in an annex.

into account, we assume a partial adjustment process.⁷ Starting from equation (9), we define the fully-adjusted level of unemployment rate (UR^*):

$$\log (UR^*(i)_t) = \beta_0 - u_{el} * \log (PAMNUR_t / PAMUR_t) + \beta_1 * SD_t \quad (10)$$

where, in order to simplify the presentation, SD represents a vector of the structural and demographic variables presented above (UIG , $UNION$, WMR , $FERT$...). The adjustment process is defined as:

$$\log (UR(i)_t) = \log (UR(i)_{t-1}) + \phi [\log (UR^*(i)_t) - \log (UR(i)_{t-1})] \quad (11)$$

Replacing equation (10) in (11):

$$\begin{aligned} \log (UR(i)_t) &= (1 - \phi) * \log (UR(i)_{t-1}) + \phi \beta_0 + \phi \beta_1 * SD_t \\ &\quad - \phi u_{el} * \log (PAMNUR_t / PAMUR_t) \end{aligned} \quad (12)$$

Rewriting the coefficients we have: i) $\phi \beta_0 = \theta_1$, ii) $\phi \beta_1 = \theta_2$, iii) $-\phi u_{el} = \theta_3$, iv) $(1 - \phi) = \theta_4$, and equation (12) becomes:

$$\begin{aligned} \log (UR(i)_t) &= \theta_1 + \theta_2 * SD_t + \theta_3 * \log (PAMNUR_t / PAMUR_t) + \\ &\quad \theta_4 * \log (UR(i)_{t-1}) \end{aligned} \quad (13)$$

As mentioned earlier, the coefficient on the prime-age male unemployment rate gap (θ_3) can be interpreted as the short-term elasticity of that cohort's unemployment rate to the prime-age male gap.

7. It must be noted that a limitation of this approach is that it imposes the same adjustment structure on each of the explanatory variables.

Table 2.3.1
Unemployment Rate Gap Equations¹
1961:1 to 1989:2

	<u>Male</u>			<u>Female</u>	
	<u>Young</u>	<u>Older</u>	<u>Young</u>	<u>Prime-age</u>	<u>Older</u>
CONSTANT	0.39 (2.37)	-0.27 (-1.06)	-0.43 (-1.48)	-0.11 (-2.52)	0.49 (5.28)
PAMNUR/PAMUR	0.33 (4.27)	0.19 (4.15)	0.42 (6.54)	0.29 (5.83)	0.57 (5.26)
UNION	0.003 (0.31)	*	0.0006 (0.07)	*	*
LFF2554/LFM2554	0.30 (2.21)	1.26 (2.35)	1.14 (4.62)	0.80 (5.97)	0.96 (4.75)
LF1524/LFM2554	0.39 (1.98)	*	1.60 (5.60)	0.73 (6.46)	*
UIG	*	*	0.03 (2.52)	0.04 (3.37)	0.08 (2.67)
UR(i) _{t-1}	0.64 (9.13)	0.73 (13.83)	0.37 (4.57)	0.53 (7.33)	0.22 (2.45)
TREND	*	-0.005 (-2.11)	*	*	*
FERT(i)	*	*	0.002 (2.22)	*	*
CRSQ	0.969	0.921	0.983	0.987	0.736
SSR	0.352	0.508	0.265	0.262	4.420
Standard error	0.057	0.069	0.050	0.049	0.201
C. of Variation	0.004	0.013	0.004	0.008	0.044

(1) t statistics in parenthesis.

The results include a number of notable features. First, the coefficient on the lagged dependent variable is, not surprisingly, large and always significant. This supports the assumed presence of an adjustment process in the labour market. Second, the UI generosity index has a statistically significant impact on female unemployment rates. The long-term elasticity of the total unemployment rate with respect to UI generosity obtained by weighting the disaggregated long-term elasticities is estimated to be 0.03 in 1972 and 0.05 in 1988. The calculation was done for two different points in time as the share of females

in the labour force has increased over time.⁸ Finally, since almost none of the factors indicated above were significant in explaining the unemployment rates for older cohorts, a time trend was introduced in these cohorts' equations to capture other unspecified structural factors. The time trend turned out to be significant in the older male equation only. Short- and long-term elasticities with respect to the prime-age male unemployment rate gap are presented in Table 2.3.2.

Table 2.3.2
Unemployment Gap Elasticities for Each Cohort
With Respect to the Prime-age Male Gap
1961:1 to 1989:2

	<u>Short-term</u>	<u>Long-term</u>
Young males	0.33	0.94
Young females	0.42	0.68
Prime-age females	0.29	0.63
Older males	0.19	0.72
Older females	0.57	0.73

Once the unemployment rate equations have been estimated, the normal unemployment rate series for each cohort can be calculated. This is done by simulating equation (13) for each cohort, with the prime-age-male unemployment rate gap set equal to unity. Chart 2.1 presents normal and observed unemployment rates for each cohort.

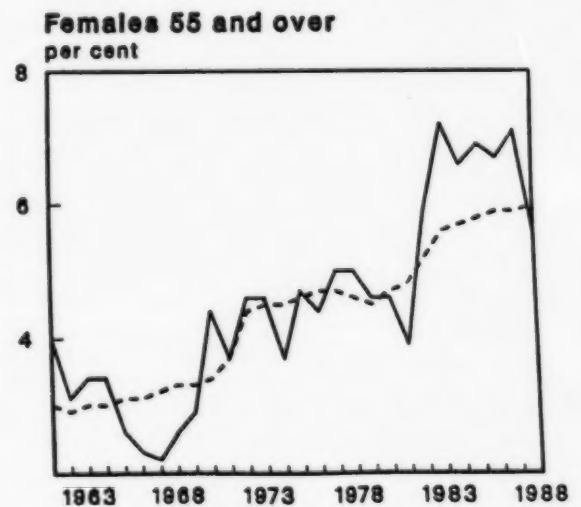
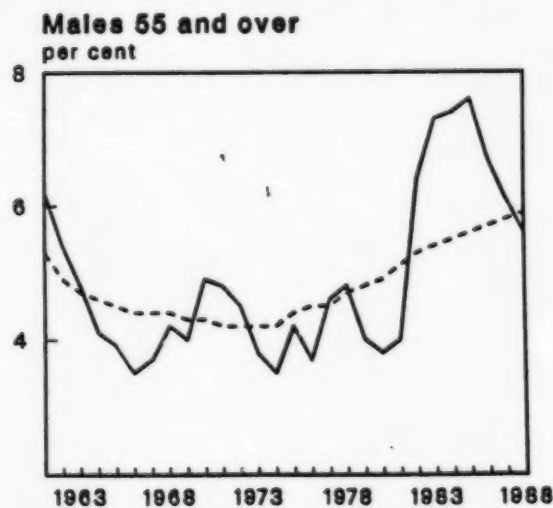
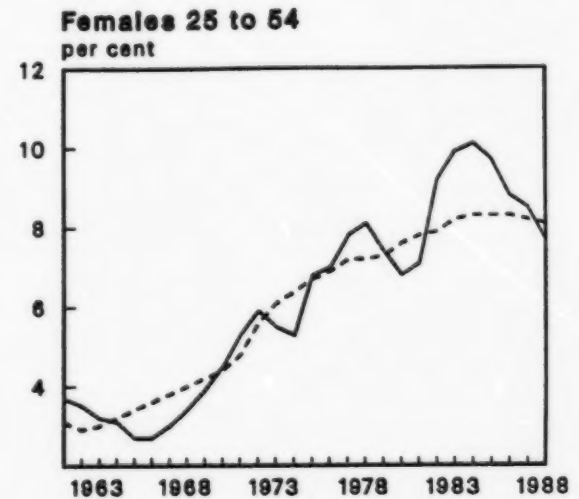
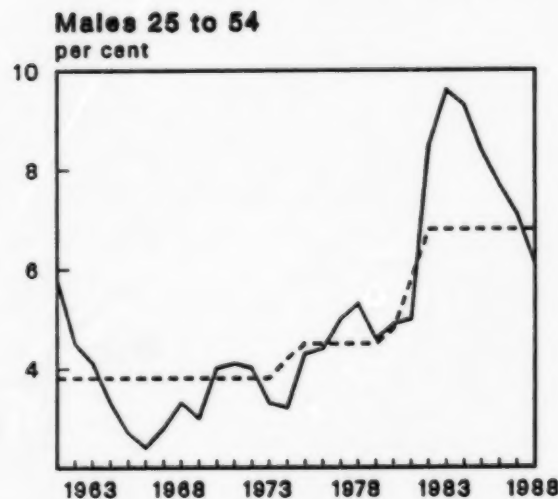
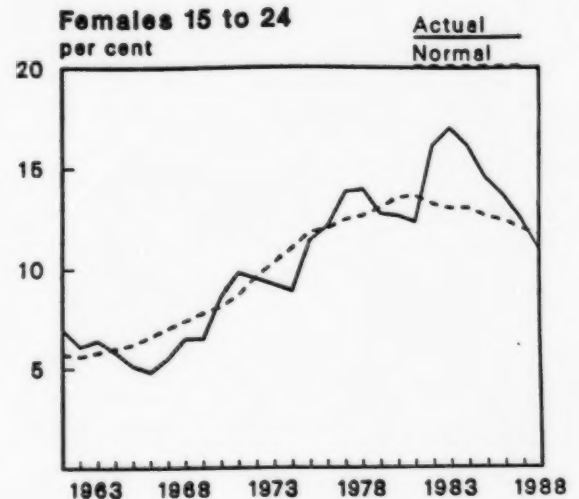
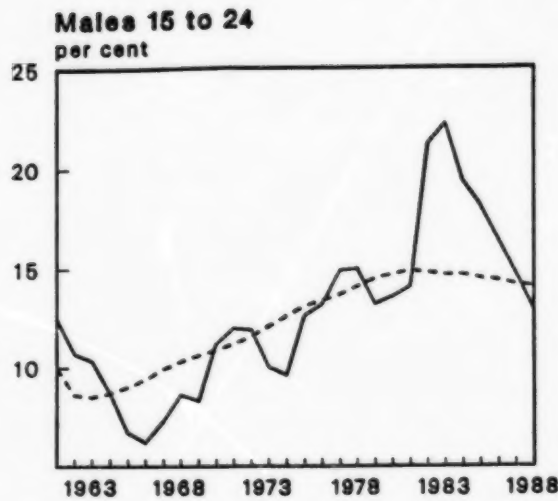
2.3.2 Normal Employment and Total Smoothed Hours Worked in the Commercial Sector

Once the normal unemployment rate is calculated for each cohort, smoothed employment for each is derived by multiplying the appropriate smoothed labour force series by one minus the respective adjusted unemployment rate. The smoothed labour force for each age-sex cohort is calculated as the product of the cohort's source population times its smoothed participation rate.

-
8. The long-term elasticity of the female unemployment rates with respect to the UI generosity index is obtained by multiplying the coefficients of UIG by the average value of this variable and dividing the result by 1 minus the coefficient of the lagged dependent variable. The elasticity of the aggregate unemployment rate with respect to the UI generosity index is obtained by weighting the elasticities obtained previously for the female cohorts by the shares of each of these cohorts in the total labour force. The results suggest, for example, that the 1972 reform of the UI program resulted in approximately a 0.5-percentage-point increase in the aggregate unemployment rate.

Chart 2.1

MALE AND FEMALE UNEMPLOYMENT RATES ACTUAL AND NORMAL



Generally, participation rates do not follow cyclical patterns as pronounced as those observed for unemployment rates or real output. However, rates for certain cohorts do exhibit some cyclical sensitivity, especially those cohorts having a weaker attachment to the labour force. To purge the various participation rates of this cyclical element, a four-year centered moving average is applied to each series. Using quarterly data, this can be represented by the following equation:

$$PRS(i)_t = \frac{\sum_{t=-8}^8 PR(i)_t}{17} \quad (15)$$

where:

PRS(i): Smoothed participation rate of cohort i at time t.
 PR(i): Participation rate of cohort i at time t.
 i: Young males, young females, prime-age males, prime-age females, older males, older females.

Chart 2.2 presents the observed and smoothed participation rates for each cohort. It is interesting to note that despite the simplicity of the procedure used, it is fairly effective in eliminating cyclical movements in the participation rates.

2.3.3 Smoothed Hours Worked

The discussion of normal employment presented so far has focused on the number of employees while ignoring trends in hours worked. The steady decline in average weekly hours worked per employee over the post-war period, however, suggests that the trend in hours worked is an important element in measuring the normal labour input. Table 2.3.3 presents average weekly hours worked in the total economy and in the commercial sector for selected years over the 1961 to 1988 period as well as the share of commercial sector employment in total employment.

The two average-weekly-hours-worked series exhibit some cyclicity. This has been removed by smoothing using a four-year centred moving average.

-
9. As shown on the chart, the participation rate is very procyclical, suggesting that individuals enter the labour force when the economy grows relatively rapidly and leave it when the growth in the economy is relatively weak.

Chart 2.2

MALE AND FEMALE PARTICIPATION RATES ACTUAL AND NORMAL

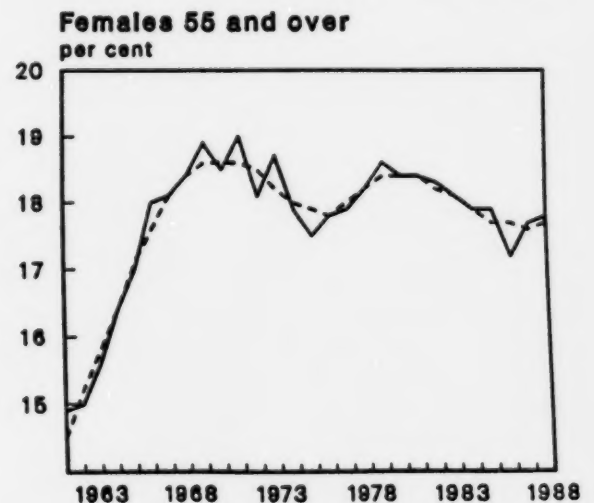
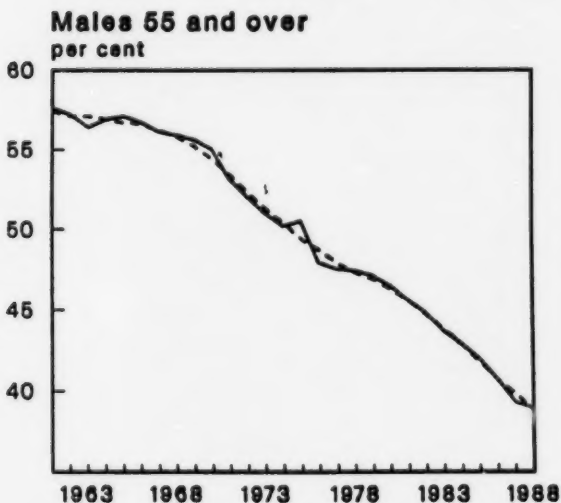
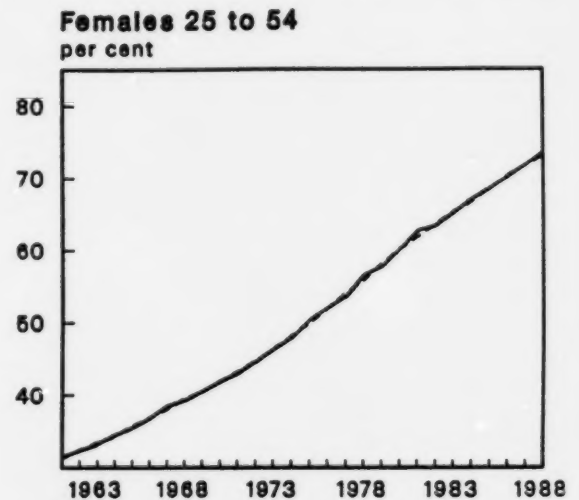
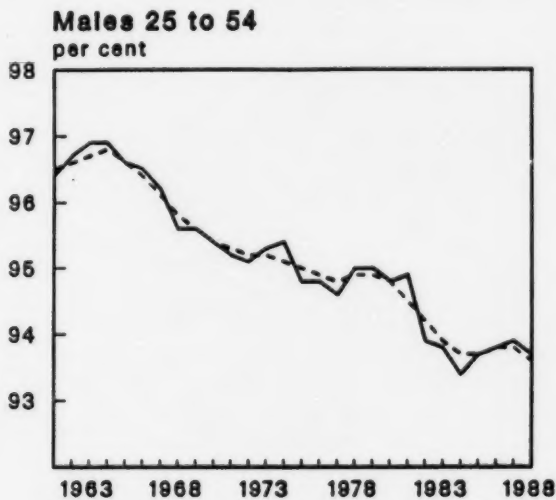
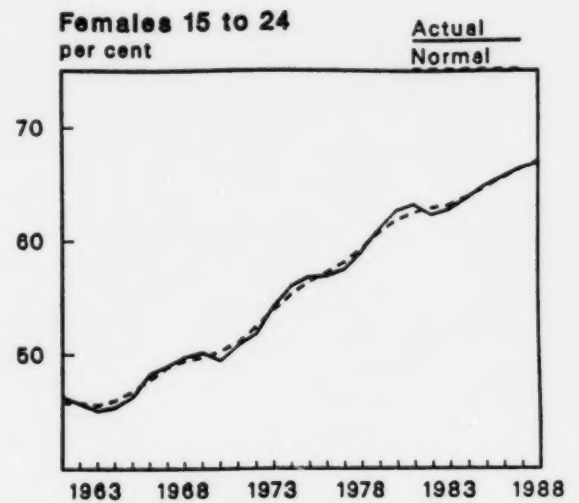
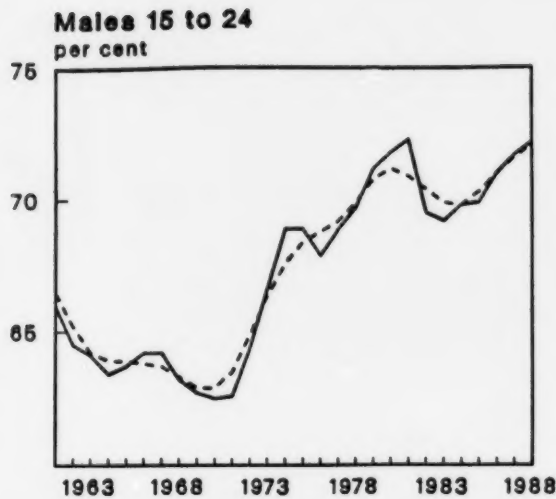


Table 2.3.3
Hours Worked and Employment

	<u>Average Weekly Hours Worked</u>		<u>Share of Commercial Sector Employment in Total Employment</u>
	<u>Commercial Sector</u>	<u>Total Economy</u>	
1961	40.5	40.8	.826
1966	39.7	38.7	.817
1971	37.8	36.7	.785
1976	36.4	35.7	.782
1981	35.6	34.9	.784
1986	35.6	34.7	.785
1987	35.7	34.7	.786
1988	35.9	35.0	.790

2.3.4 Results

Chart 2.3 presents the evolution of the observed and smoothed total hours worked for the commercial sector. It is apparent that total hours worked decreased substantially during and following the 1981-1982 recession and that the gap between normal and actual was quite large at that time.

2.4 Estimating the Normal Level of the Capital Input

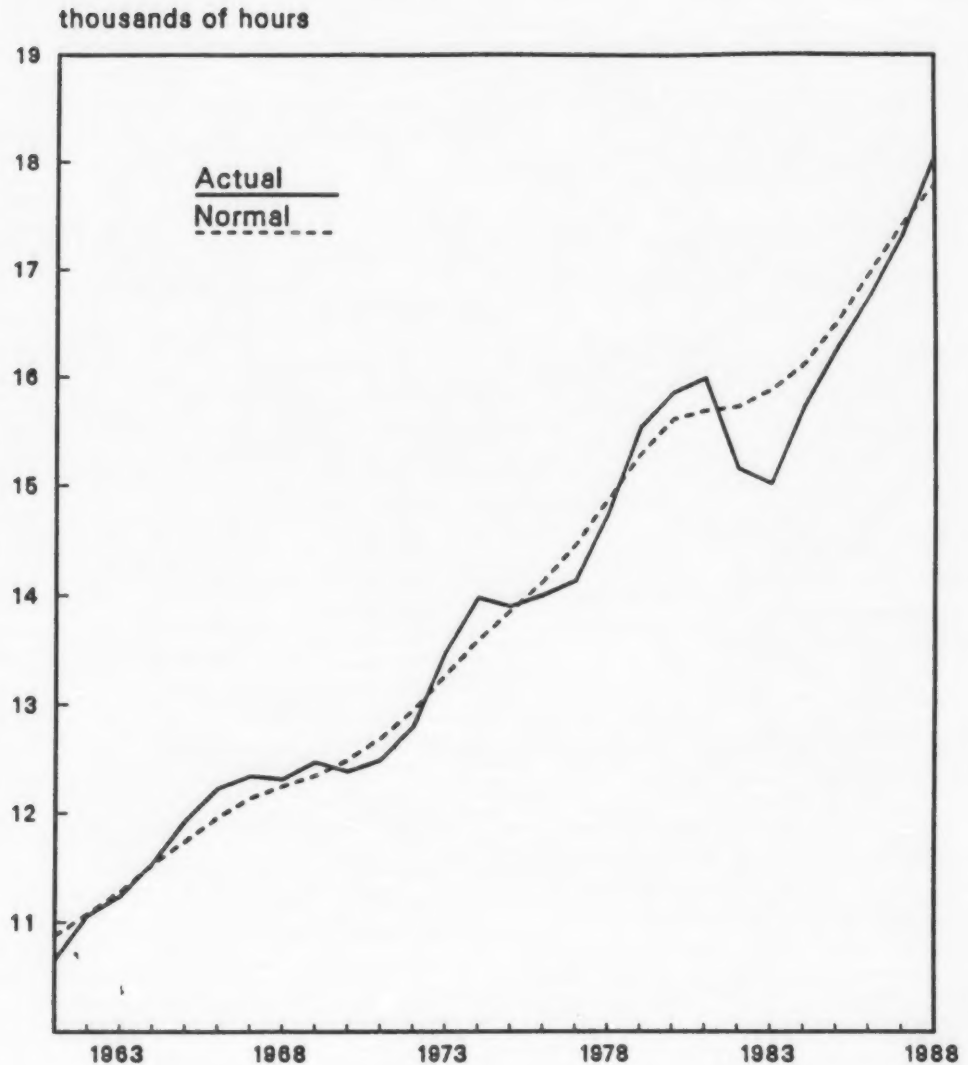
The estimation procedure for deriving the normal level of capital is straightforward. The effective level of capital used in the production process K^e can be defined as:

$$K^e = \theta * K \quad (16)$$

where K is the total stock of capital, including machinery and equipment and non-residential structures in the commercial sector, and θ is the capital utilization coefficient reflecting the intensity of capital utilization at different points in the cycle. The Bank of Canada (1980) capacity utilization rate has been used to measure θ . The Bank of Canada's capacity utilization rate is defined as aggregate actual output at time t divided by aggregate potential output during that period. The methodology requires that the trend of the potential capital-output ratio be determined by inspection from the historical pattern of the actual capital-output ratio. This is done in two steps. First, the historical minimum capital-output ratio observed is chosen as the starting point for the potential capital-output ratio. At this point the output gap, which is the difference between the actual and the potential

Chart 2.3

**HOURS WORKED IN COMMERCIAL SECTOR
ACTUAL AND NORMAL**



capital-output ratio, is by definition zero. Second, any trend in the industry's capital-output ratio after that minimum point is estimated by the average change between this minimum ratio and the next lowest point observed in the following historical record. This means that if a new minimum is observed at some point in the future, the historical potential capital-output ratio must be revised.¹⁰

Capacity utilization rates over each cycle are normalized so that their average -- and consequently the normal capacity utilization rate over each cycle -- is equal to unity. Accordingly, equation (17) can be rewritten as:

$$K^e = \theta_n * K \quad (17)$$

where θ_n is the normalized capacity utilization rate. Normal effective capital, K^n can be obtained by multiplying the capital stock by the normal rate of capacity utilization. Since the latter is equal to unity, we have:

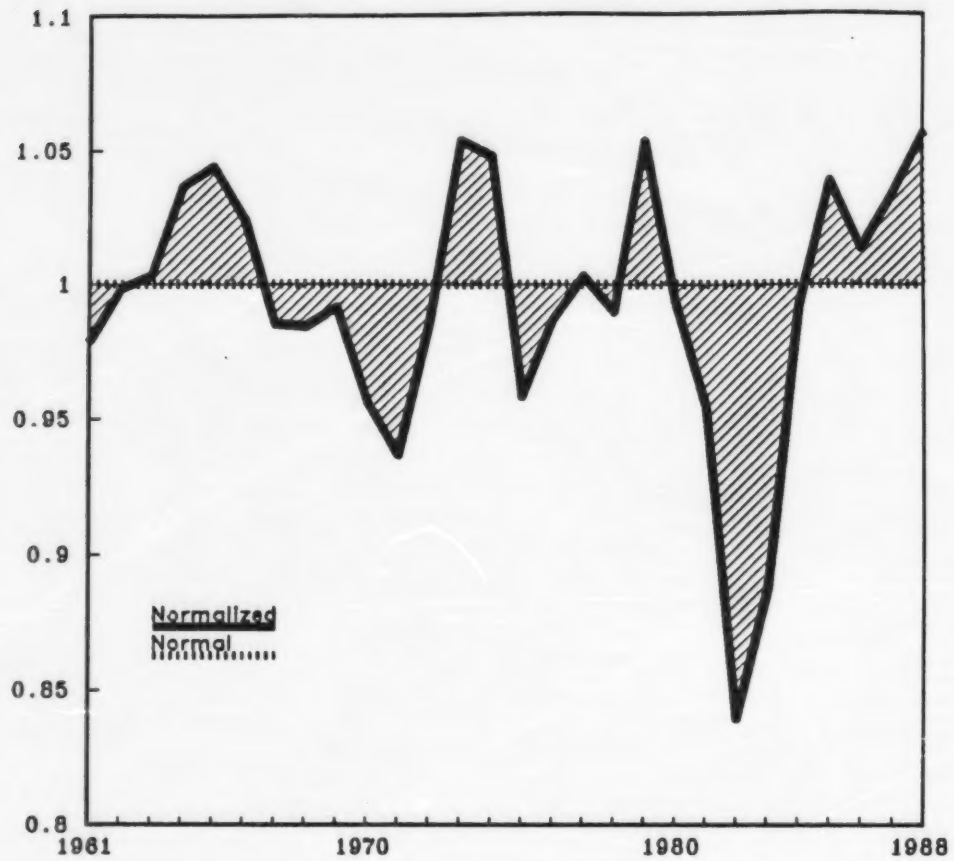
$$K^n = K \quad (18)$$

The normal level of the capital input is simply the total capital stock owned by the commercial sector. Chart 2.4 presents both the normalized and normal rates of capacity utilization over the 1961 to 1988 period.

10. For more details about the Bank's methodology in measuring capacity utilization and in determining the potential capital-output ratio use in the computation, refer to the analytical note in the Bank of Canada Review (May 1980).

Chart 2.4

Rate of Capacity Utilization
1961 to 1988



3.0 Technology and Trend Multi-factor Productivity

In addition to the normal levels of labour and capital inputs, technology and trend multi-factor productivity must be determined in order to obtain the normal level of output for the commercial sector.

The first part of this section discusses the production technology and the calculation of multi-factor productivity. The second part discusses the estimation of trend multi-factor productivity. The level of cyclically-adjusted output is then calculated for both the historical and forecast periods.

3.1 Technology and Total Factor Productivity

There are a number of possibilities for the specification of the technology linking the factors of production and the level of output. In this study, a disembodied Cobb-Douglas specification of the production function, with Hicks-neutral technological progress and constant returns to scale is adopted. This formulation is used in the Canadian economic and forecasting model (CEFM) in the Department of Finance. Several studies on functional forms have been conducted by the department. These showed that a CES functional form gives almost the same coefficients as the Cobb-Douglas. Further, use of a translog production function did not improve the estimation results, despite the effort undertaken. As well, the Cobb-Douglas formulation is widely used in other models and therefore allows a direct comparison of our estimates with those of other studies.

The production function has the form:

$$Y = A_0 e^{\delta t} * LFEHC^{\alpha} * (\theta_n K)^{(1-\alpha)} \quad (19)$$

where

$$K = KINRC^{\beta} * KIME^{(1-\beta)}$$

where Y is real commercial sector output, $A_0 e^{\delta t}$ is multi-factor productivity, LFEHC is the total hours worked in the commercial sector and K is the real effective capital owned by the commercial sector. This variable is formed as an aggregate of the real stocks of machinery and equipment (KIME) and non-residential structures (KINRC) combined using a Cobb-Douglas aggregator. The coefficient α is the historical average share of

commercial sector labour income in total commercial sector factor income. Consequently $(1-\alpha)$ represents the share of income accruing to capital. The parameter θ_n is the Bank of Canada capacity utilization rate normalized to average one over the period. The coefficient δ represents the growth in multi-factor productivity.

The value of multi-factor productivity (MP) is calculated as the residual contribution to production in excess of the contribution of capital and labour.

$$MP = Y/[LFEHC^\alpha * (\theta_n * (KINRC(t-1)^\beta KIME(t-1)^{(1-\beta)})^{(1-\alpha)}] \quad (20)$$

A time series for MP is obtained by dividing real commercial output by the contributions of capital and labour to real commercial sector output. The estimation of trend multi-factor productivity (TMP) starting from this series is described in the following section.

3.2 Estimating Trend Multi-factor Productivity

Multi-factor productivity can exhibit cyclical behaviour. In order to purge the cyclical element, we have estimated trend levels of this series, over the cycles previously identified, using a methodology similar to James (1989). The specification used is:

$$\begin{aligned} \log(MP) = & (\beta_0 + \beta_1 * T) * D_1 + \\ & (\beta_0 + (\beta_1 - \beta_2) * 54 + \beta_2 * T) * D_2 + \\ & (\beta_0 + (\beta_1 - \beta_2) * 54 + (\beta_2 - \beta_3) * 75 + \beta_3 * T) * D_3 \\ & (\beta_0 + (\beta_1 - \beta_2) * 54 + (\beta_2 - \beta_3) * 75 + (\beta_3 - \beta_4) * 82 + \beta_4 * T) * D_4 \end{aligned} \quad (21)$$

where D_{i+1} is defined as:

$$D_{i+1} = \begin{cases} 1 & \text{if } T_i \leq T < T_{i+1} \\ 0 & \text{if } T < T_i, \quad T \geq T_{i+1} \end{cases}$$

The interval $[T_i, T_{i+1}]$ represents each of the various cycles and T is defined as a time index.

This specification imposes the condition that there is no discontinuity between two adjacent cycles in the level of trend multi-factor productivity. The variables D_1 to D_4 are dummy variables taking values of 1 and 0 for each of the identified cycles. The coefficient β_i can be interpreted as the quarterly

growth rate of trend multi-factor productivity over each cycle. Equation (21) was estimated using OLS over the 1961:1 to 1988:4 period. The estimated annualized growth rates are presented in Table 3.2.1 for the various cycles.

Table 3.2.1

Annual Growth of TMP
(in percentage)

1961:1 - 1974:2	2.61
1974:3 - 1979:3	0.65
1979:4 - 1981:2	-0.09
1981:3 - 1988:4	0.04

The results show a continuing decline in TMP over the 1961:1 to 1981:2 period. This result is generally confirmed by other studies such as Englander and Mittlstädt (1988), the Economic Council (1985) and James (1989). Chart 3.1 shows actual and trend multi-factor productivity over the 1961 to 1988 period.

After estimation, it is possible to simulate equation (21) to obtain the level of trend factor productivity. Once trend multi-factor productivity is estimated, cyclically-adjusted output can be calculated. Substituting for the normal levels of employment (NEC) in equation (19), setting the normalized capacity utilization rate to 1 and replacing multi-factor productivity by its trend level, we get:

$$YNC = TMP * NEC^{\alpha} * [KINRC(t-1)^{\beta} * KIME(t-1)^{(1-\beta)}]^{\alpha} \quad (22)$$

To obtain total cyclically-adjusted output, the actual level of real non-commercial output is added to normal commercial output since real non-commercial output is assumed to be non-cyclical.

4.0 Cyclically-adjusted Output Estimates

This section presents estimates of cyclically-adjusted output based on the methodology discussed above.

Chart 3.1

Multi-factor Productivity
1961 to 1988

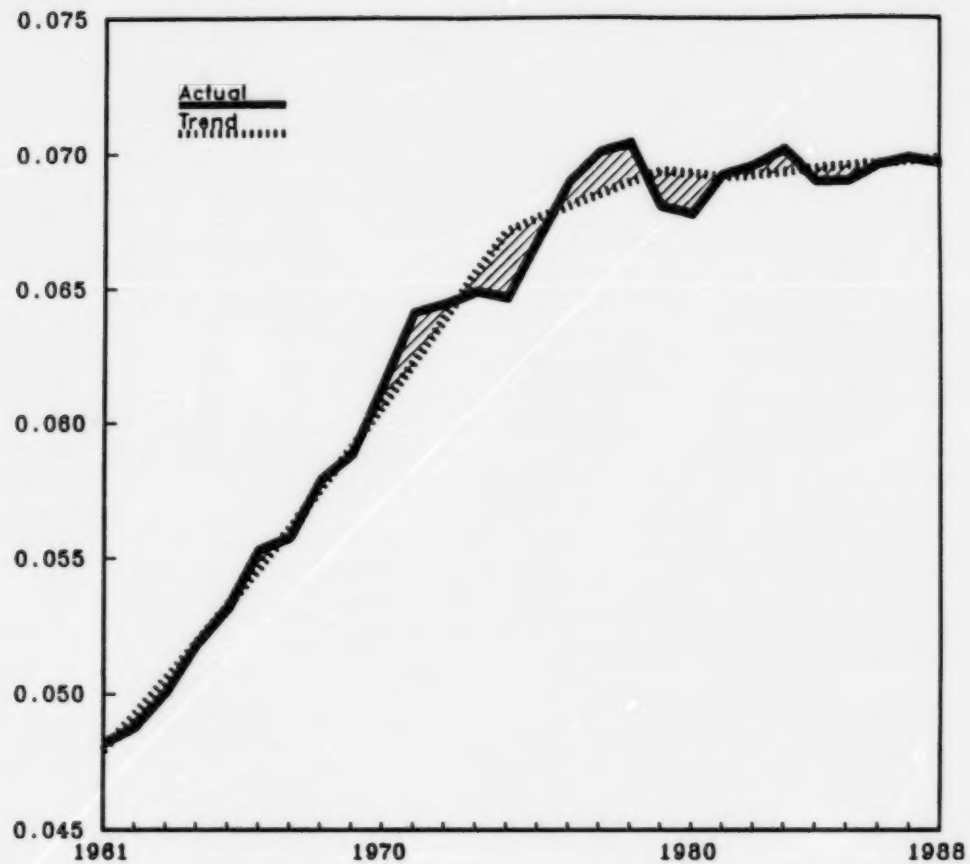
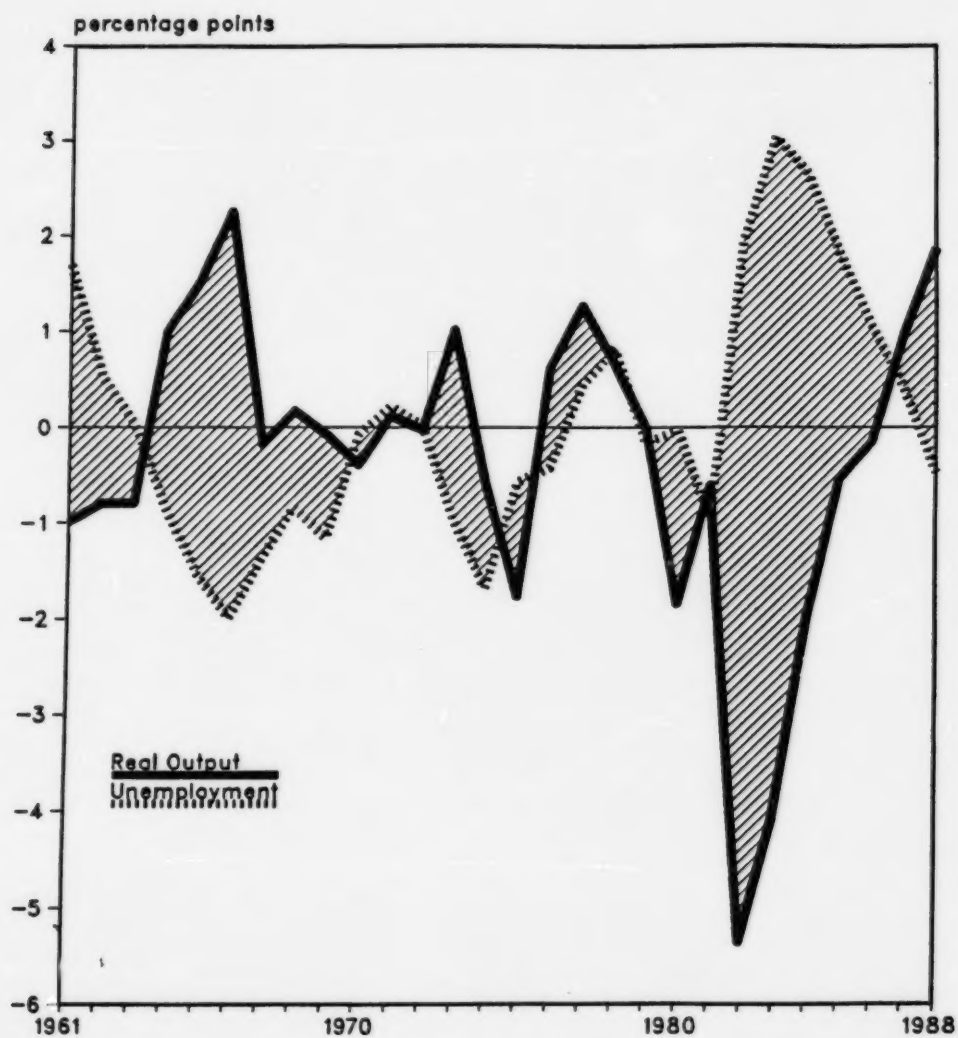


Chart 4.1

Output and Unemployment Gaps 1961 to 1988



4.1 Results

Chart 4.1 contains the output and unemployment gaps over the 1961 to 1989 period. The output gap is defined as real total output at factor cost less total cyclically-adjusted output, expressed as a percentage of cyclically-adjusted output. The unemployment rate gap is the difference between the observed and normal rates of unemployment.

The output gap became positive by the mid-1960s following a rebound in economic activity after the slowdown in the late 1950s and early 1960s. The gap remained positive through the lengthy expansion of the 1960s. Between the late 1960s and 1970s, the gap alternated from positive to negative. The output gap reached its lowest level in the 1981-1982 recession, with actual output about $5\frac{1}{2}$ per cent below cyclically-adjusted output, while by 1988 a positive gap of close to 2 per cent had emerged following rapid post-recession growth.

Table 4.1.1 presents the contributions of labour, capital and trend multi-factor productivity to the growth of cyclically-adjusted output over the four historical periods from 1961 to 1989 and prospectively to 1995. The main features of this decomposition are the following:

Historical

- Since 1974, the average annual growth rate of cyclically-adjusted output declined significantly from 5.4 to roughly 3.0 per cent at present.
- Growth in commercial sector cyclically-adjusted output also slowed significantly in the post-1974 period. Most of this decline is attributable to the reduction in trend multi-factor productivity growth. From an average annual growth of 2.6 per cent in the 1960s and early 1970s, the growth in trend multi-factor productivity declined to 0.7 per cent from 1974 to 1979 and was negative or very small thereafter.
- The contributions of capital to the growth of cyclically-adjusted output increased over the 1961:1 to 1981:2 period but declined thereafter. Examination of the underlying components shows that this result is mostly due to a rapidly growing stock of machinery and equipment while the growth in the stock of non-residential structures remained relatively constant until 1981:2. However, the growth in both components subsequently slowed.

Table 4.1.1
Contributions to Real Cyclically-adjusted Output Growth*
(Average annual percentage change)

	1961:1 to <u>1974:2</u>	1974:3 to <u>1979:3</u>	1979:4 to <u>1981:2</u>	1981:4 to <u>1989:2</u>	1990:1 to <u>1995:4</u>
Real GDP at factor cost	5.43	3.36	3.33	2.96	3.16
Non-commercial sector	5.28	1.39	3.54	2.80	2.94
Commercial sector GDP	5.50	4.10	3.26	3.02	3.24
Capital	1.79	1.94	2.58	1.75	1.92
Machinery and Equipment	0.68	0.89	1.34	1.00	1.10
Non-Residential	1.11	1.05	1.24	0.74	0.82
Labour	1.10	1.53	0.85	1.23	0.94
Hours	-0.46	-0.29	-0.47	0.01	-0.32
Employment	1.57	1.82	1.33	1.22	1.26
Population	1.49	1.34	1.19	0.74	0.81
Part Rate	0.37	0.63	0.36	0.33	0.31
Normal Unemployment					
Rate	-0.08	-0.09	-0.09	0.07	0.03
Commercial Share	-0.25	-0.03	-0.13	0.08	0.11
TMP	2.61	0.65	-0.15	0.03	0.39

* Contributions may not sum to totals due to rounding.

- The contribution of normal labour input to cyclically-adjusted output growth was more variable over the cycles. There seems to be no significant trend in this contribution. The absence of any significant trend in the overall contribution of normal labour input masks some important shifts in the underlying components, however.
- The growth in source population has declined steadily since the beginning of the 1960s. From an average annual growth of 1.5 per cent in the 1960s and early 1970s, it declined to 0.7 per cent in the 1980s. The negative contribution of this development to cyclically-adjusted output growth was offset mainly by an increase in the participation rate in the 1970s, and by a slowdown in the downward trend in average hours worked in the commercial sector in the 1980s.

Forecast

- Cyclically-adjusted output growth is projected to increase 0.2 percentage point to 3.2 per cent per year over the medium-term forecast horizon to 1995.
- The most notable feature of the forecast results is the increase in the growth of trend multi-factor productivity of close to 0.4 percentage point per year. This reflects the expected productivity improvements from the government's structural policy initiatives, including the Free Trade Agreement with the United States, corporate income tax reform and sales tax reform.
- The growth of the capital stock is up 0.2 percentage point per year. This reflects the increase incentive to invest associated with the government's structural policies.
- The growth of normal labour input is down 0.3 percentage point per year. This almost exclusively reflects a further downward trend in average hours worked in the commercial sector.

Bibliography

1. Armstrong, P. and Hugh Armstrong (1984), The Double Ghetto, McClelland and Stewart Limited.
2. Bank of Canada (1980), "Measuring Capacity Utilization: A Technical Note", Bank of Canada Review, May.
3. Bredenkamp, H. (1988), "The Cyclically-Adjusted Deficit as a Measure of Fiscal Stance" HM Treasury, No. 102, April 1988.
4. Bruce, N. and Douglas Purvis (1986), Evaluating the Deficit: The Case for Budget Cuts, C.D. Howe Institute.
5. Buiter, W.H. (1988), "The Theory of Optimum Deficits and Debt", National Bureau of Economic Research, Working Paper No. 1232.
6. Clark, Peter K. (1979), "Potential GNP in the United States, 1948-80", Review of Income and Wealth.
7. Ciuriak, D., and Harvey Sims (1980), "Participation Rate and Labour Force Growth in Canada", Department of Finance.
8. Cross, Philip (1982), "The Business Cycle in Canada 1950-1981", Statistics Canada Current Economic Analysis.
9. Denison, E.F. (1981), "Changes in the Concept and Measurement of Potential Output in the United States of America", Brookings General Series Reprint.
10. Denny, Michael (1986), "The Prospects for Productivity" in Economic Growth: Prospects and Determinants, Volume 22 of the research program of the Royal Commission on the Economic Union and Development Prospects for Canada.
11. Economic Council of Canada (1985), "Strengthening Growth, Options and Constraints", 22nd Annual Review.
12. Englander, A.S. and A. Mittelstädt (1988), "Total Factor Productivity: Macroeconomic and Structural Aspects of the Slowdown", OECD Economic Studies, No. 10 (Spring).
13. Fortin, P. (1980), "Unemployment Insurance and the Choice of a Labour Market Habitat", Miméo de l'Université Laval.
14. Fortin, P. (1984), "How Natural is Canada's High Unemployment Rate?", European Economic Review, Volume 33, No. 1, pp 89-105.
15. Gigliotti, T. (1990), "Cyclical-Adjusted Budget Balances", Department of Finance, Working Paper Series, forthcoming.

16. Grignon, L. (1984), "Révision des élasticités conjoncturelles des taux de chômage: 1947-1983", Department of Finance mimeo.
17. James, S. (1988), "Potential Output and Trend Total Factor Productivity", Department of Finance mimeo.
18. _____ and Kei Moray (1986), "Geographic Labour Mobility in Canada: An Examination of its Adequacy", Department of Finance mimeo.
19. Gunderson, Morley (1980), "The Male-Female Earnings Gap: A Current Assessment", report prepared for the Ontario Ministry of Labour.
20. _____ (1982), "The Male-Female Earnings Gap in Ontario: A Summary", Research Branch Ontario Ministry of Labour.
21. _____ (1986), "Discrimination, Equal Pay, and Equal Opportunities in the Labour Market" in Work and Pay: The Canadian Labour Market, Volume 17 of the research program of the Royal Commission on the Economic Union and Development Prospects for Canada.
22. Halliwell, Cliff (1986), "Forecast Equations for the Participation Rates in QFS", Department of Finance mimeo.
23. Helliwell, John F. (1984), "Stagflation and Productivity Decline in Canada, 1974-82", Canadian Journal of Economics XVII, No. 2.
24. _____, Mary E. MacGregor and Tim Padmore (1986), "Economic Growth and Productivity in Canada 1955-90", in Economic Growth: Prospects and Determinants, Volume 22 of the research program of the Royal Commission on the Economic Union and Development Prospects for Canada.
25. International Monetary Fund (1987), "Potential Output in the Major Industrial Countries", World Economic Outlook: Staff Studies.
26. Lester, John (1978), "Calculation of the Cyclically-Adjusted Budget Balance", Department of Finance mimeo.
27. _____ (1979), "The Cyclically-Adjusted Rate of Unemployment", Department of Finance mimeo.
28. MacGregor, Mary (1988), "Stability and Consistency of Natural Rate Estimates", Department of Finance mimeo.

29. McClain, David S. and Charles A. Waite (1980), "The High Employment Budget: New Estimates 1955-80", Survey of Current Business.
30. Perry, George L. (1970), "Changing Labor Markets and Inflation", Brookings Papers on Economic Activity.
31. _____ (1971), "Labour Force Structure, Potential Output, and Productivity", Brookings Papers on Economic Activity.
32. _____ (1977), "Potential Output and Productivity", Brookings Papers on Economic Activity.
33. Rose, Graham (1987), "Non-Energy Commodity Price Developments." Department of Finance mimeo.
34. Sharpe, Andrew (1982), "A Review of the Productivity Slowdown Literature", Department of Finance mimeo.
35. _____ (1984), "Comments on The Outlook for Canadian Productivity Growth in the 1980s: A Macroeconomic Perspective", Department of Finance mimeo.
36. Sheikh, M.A. (1979), "Revisions to Normal Output", Department of Finance mimeo.

Annex 1

Data from Estimation of the Unemployment Rate Equations

	UI Generosity	Unionization	Minimum Wage	Fertility Rate	Fertility Rate
	Index UIG	Rate UNION	Index WMR	Women 15-24 FERT1524	Women 25-54 FERT2554
		(per cent)		(birth/1000 women)	
1961	0.230	31.6	0.430	138.9	99.3
1962	0.287	30.2	0.421	135.0	95.9
1963	0.300	29.8	0.456	130.4	93.1
1964	0.298	29.4	0.466	122.3	89.1
1965	0.290	29.7	0.460	111.1	79.4
1966	0.298	30.7	0.458	102.3	70.2
1967	0.284	32.3	0.452	97.9	63.9
1968	0.419	33.1	0.494	93.9	60.9
1969	0.408	32.5	0.461	91.8	60.8
1970	0.380	33.6	0.481	90.6	59.6
1971	1.271	33.6	0.464	85.2	57.0
1972	2.550	34.6	0.441	78.7	54.4
1973	2.512	36.1	0.457	75.6	53.3
1974	2.294	35.8	0.464	72.9	53.5
1975	2.239	36.9	0.464	73.7	54.3
1976	2.190	37.3	0.458	71.0	53.8
1977	2.152	38.2	0.439	69.1	53.8
1978	1.560	39.0	0.428	65.9	53.1
1979	1.210	38.3	0.425	64.6	54.2
1980	1.234	37.6	0.399	63.9	54.0
1981	1.226	37.4	0.381	62.2	53.8
1982	1.858	39.0	0.362	62.7	53.3
1983	2.169	40.0	0.350	61.4	53.6
1984	2.178	39.6	0.350	60.2	54.4
1985	2.077	39.0	0.341	58.5	54.2
1986	2.023	37.7	0.333	56.9	53.7
1987	1.866	37.6	0.340	54.8	53.2
1988	1.704	36.6	0.329	54.8	53.2

Annex 1 (continued)

Data from Estimation of the Unemployment Rate Equations

	Prime-age Male Normal Unemployment Rate	Ratio of Young Female Labour Force to Prime-age Male Labour Force	Ratio of Young Labour Force to Prime-age Male Labour Force
	PAMNUR	LFF2554/LFM2554	LF1524/LFM2554
		(per cent)	
1961	3.8	0.33	0.45
1962	3.8	0.34	0.46
1963	3.8	0.35	0.47
1964	3.8	0.37	0.49
1965	3.8	0.38	0.52
1966	3.8	0.39	0.55
1967	3.8	0.40	0.57
1968	3.8	0.42	0.58
1969	3.8	0.43	0.59
1970	3.8	0.44	0.60
1971	3.8	0.46	0.62
1972	3.8	0.47	0.63
1973	3.8	0.49	0.66
1974	4.2	0.51	0.68
1975	4.5	0.54	0.68
1976	4.5	0.55	0.68
1977	4.5	0.57	0.69
1978	4.5	0.60	0.69
1979	4.6	0.61	0.70
1980	4.8	0.64	0.70
1981	5.8	0.66	0.68
1982	6.8	0.68	0.66
1983	6.8	0.70	0.62
1984	6.8	0.73	0.61
1985	6.8	0.74	0.58
1986	6.8	0.76	0.59
1987	6.8	0.78	0.55
1988	6.8	0.80	0.53

Annex 1 (continued)

Data from Estimation of the Unemployment Rate Equations

	Male 15-24 URM1524	Unemployment Rates				Male 55+ URM55+	Female 55+ URF55+
		Female 15-24 URF1524	Male 25-54 URM2554	Female 25-54 URF2554			
					(per cent)		
1961	3.7	6.2	4.0	12.5		7.0	5.8
1962	3.5	5.4	3.1	10.7		6.1	4.5
1963	3.2	4.8	3.4	10.3		6.4	4.1
1964	3.1	4.1	3.4	8.7		5.8	3.3
1965	2.7	3.9	2.6	6.7		5.1	2.7
1966	2.7	3.5	2.3	6.2		4.8	2.4
1967	3.0	3.7	2.2	7.3		5.5	2.8
1968	3.4	4.2	2.6	8.6		6.5	3.3
1969	3.9	4.0	2.9	8.3		6.5	3.0
1970	4.5	4.9	4.4	11.2		8.6	4.0
1971	5.3	4.8	3.7	12.0		9.8	4.1
1972	5.9	4.5	4.6	11.9		9.5	4.0
1973	5.5	3.8	4.6	10.0		9.2	3.3
1974	5.3	3.5	3.7	9.6		8.9	3.2
1975	6.8	4.2	4.7	12.6		11.4	4.3
1976	7.0	3.7	4.4	13.2		12.1	4.4
1977	7.8	4.6	5.0	14.9		13.8	5.0
1978	8.1	4.8	5.0	15.0		13.9	5.3
1979	7.4	4.0	4.6	13.2		12.7	4.6
1980	6.8	3.8	4.6	13.6		12.6	4.9
1981	7.1	4.0	3.9	14.1		12.3	5.0
1982	9.2	6.4	5.9	21.2		16.1	8.5
1983	9.9	7.3	7.2	22.2		17.0	9.6
1984	10.1	7.4	6.6	19.3		16.1	9.3
1985	9.7	7.6	6.9	18.1		14.5	8.4
1986	8.8	6.7	6.7	16.4		13.6	7.7
1987	8.5	6.1	7.1	14.7		12.4	7.1
1988	7.7	5.6	5.6	12.9		11.0	6.1

Annex 1

Data from Estimation of the Unemployment Rate Equations

	UI Generosity Index UIG	Unionization Rate UNION	Minimum Wage Index WMR	Fertility Rate Women 15-24 FERT1524		Fertility Rate Women 25-54 FERT2554	
				(birth/1000 women)			
1961	0.230	31.6	0.430	138.9	99.3		
1962	0.287	30.2	0.421	135.0	95.9		
1963	0.300	29.8	0.456	130.4	93.1		
1964	0.298	29.4	0.466	122.3	89.1		
1965	0.290	29.7	0.460	111.1	79.4		
1966	0.298	30.7	0.458	102.3	70.2		
1967	0.284	32.3	0.452	97.9	63.9		
1968	0.419	33.1	0.494	93.9	60.9		
1969	0.408	32.5	0.461	91.8	60.8		
1970	0.380	33.6	0.481	90.6	59.6		
1971	1.271	33.6	0.464	85.2	57.0		
1972	2.550	34.6	0.441	78.7	54.4		
1973	2.512	36.1	0.457	75.6	53.3		
1974	2.294	35.8	0.464	72.9	53.5		
1975	2.239	36.9	0.464	73.7	54.3		
1976	2.190	37.3	0.458	71.0	53.8		
1977	2.152	38.2	0.439	69.1	53.8		
1978	1.560	39.0	0.428	65.9	53.1		
1979	1.210	38.3	0.425	64.6	54.2		
1980	1.234	37.6	0.399	63.9	54.0		
1981	1.226	37.4	0.381	62.2	53.8		
1982	1.858	39.0	0.362	62.7	53.3		
1983	2.169	40.0	0.350	61.4	53.6		
1984	2.178	39.6	0.350	60.2	54.4		
1985	2.077	39.0	0.341	58.5	54.2		
1986	2.023	37.7	0.333	56.9	53.7		
1987	1.866	37.6	0.340	54.8	53.2		
1988	1.704	36.6	0.329	54.8	53.2		

Annex 1 (continued)

Data from Estimation of the Unemployment Rate Equations

	Prime-age Male Normal Unemployment Rate	Ratio of Young Female Labour Force to Prime-age Male Labour Force	Ratio of Young Labour Force to Prime-age Male Labour Force
		LFF2554/LFM2554	LF1524/LFM2554
	PAMNUR		
		(per cent)	
1961	3.8	0.33	0.45
1962	3.8	0.34	0.46
1963	3.8	0.35	0.47
1964	3.8	0.37	0.49
1965	3.8	0.38	0.52
1966	3.8	0.39	0.55
1967	3.8	0.40	0.57
1968	3.8	0.42	0.58
1969	3.8	0.43	0.59
1970	3.8	0.44	0.60
1971	3.8	0.46	0.62
1972	3.8	0.47	0.63
1973	3.8	0.49	0.66
1974	4.2	0.51	0.68
1975	4.5	0.54	0.68
1976	4.5	0.55	0.68
1977	4.5	0.57	0.69
1978	4.5	0.60	0.69
1979	4.6	0.61	0.70
1980	4.8	0.64	0.70
1981	5.8	0.66	0.68
1982	6.8	0.68	0.66
1983	6.8	0.70	0.62
1984	6.8	0.73	0.61
1985	6.8	0.74	0.58
1986	6.8	0.76	0.59
1987	6.8	0.78	0.55
1988	6.8	0.80	0.53

Data from Estimation of the Unemployment Rate Equations

	Unemployment Rates			
	Male 15-24 URM1524	Female 15-24 URF1524	Male 25-54 URM2554	Female 25-54 URF2554
1961	3.7	6.2	4.0	12.5
1962	3.5	5.4	3.1	10.7
1963	3.2	4.8	3.4	10.3
1964	3.1	4.1	3.4	8.7
1965	2.7	3.9	2.6	6.7
1966	2.7	3.5	2.3	6.2
1967	3.0	3.7	2.2	7.3
1968	3.4	4.2	2.6	8.6
1969	3.9	4.0	2.9	8.3
1970	4.5	4.9	4.4	11.2
1971	5.3	4.8	3.7	12.0
1972	5.9	4.5	4.6	11.9
1973	5.5	3.8	4.6	10.0
1974	5.3	3.5	3.7	9.6
1975	6.8	4.2	4.7	12.6
1976	7.0	3.7	4.4	13.2
1977	7.8	4.6	5.0	14.9
1978	8.1	4.8	5.0	15.0
1979	7.4	4.0	4.6	13.2
1980	6.8	3.8	4.6	13.6
1981	7.1	4.0	3.9	14.1
1982	9.2	6.4	5.9	21.2
1983	9.9	7.3	7.2	22.2
1984	10.1	7.4	6.6	19.3
1985	9.7	7.6	6.9	18.1
1986	8.8	6.7	6.7	16.4
1987	8.5	6.1	7.1	14.7
1988	7.7	5.6	5.6	12.9